

1 What is claimed is:

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3 1. A method for determining the fracture toughness of a ball
4 having an indentation defining an equator of the ball, the
5 equator defining north and south poles of the ball, the
6 indentation having precracks and a precrack length, the method
7 comprising the steps of,

8 applying an applied load in compression through opposing
9 hemispherical surfaces having an arc length angle of less than
10 ninety degrees, the opposing hemispherical surfaces conforming
11 to the surfaces of the ball respectively at the north and south
12 poles so that the ball bulges outwardly at the equator
13 producing tensile stresses,

14 load determining a critical applied load when the precrack
15 begins to grow under the tensile stresses at the equator, and

16 toughness determining the fractured toughness of the ball
17 from the precrack length and the critical applied load.

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20 2. The method of claim 1 wherein,

21 the fracture toughness is less than $15.0 \text{ MPa}\sqrt{\text{m}}$.

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24 3. The method of claim 1 wherein,

25 the arc length angle is $75^\circ \pm 10^\circ$.

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27 4. The method of claim 1 wherein,

28 the precrack length is less than 1.33 mm.

- 1 5. The method of claim 1 wher in,
2 the ball is made of silicon nitride.
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- 4 6. The method of claim 1 wherein,
5 the ball is a made of a ceramic material.
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- 7 7. The method of claim 1 wherein,
8 the ball is made of steel.
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- 10 8. The method of claim 1 wherein,
11 the indentation is a pyramidal indent providing a half penny
12 crack defining the precrack.
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- 14 9. The method of claim 1 wherein,
15 the indentation is a Vickers indent providing a half penny
16 crack defining the precrack.
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- 18 10. The method of claim 1 wherein, the toughness determining
19 step comprises the step of computing the toughness from a
20 fracture toughness equation $K=[1.13-0.09(A/C)]\sqrt{[\pi/Q\sigma^2A]}$, wherein
21 Q is a geometric factor of the indent such that
22 $Q=1+1.464(A/C)^{1.65}$, σ is an applied stress field created in the
23 ball under the applied load, K is the fracture toughness, C is a
24 half penny crack radius of the precrack on the surface of the
25 ball, and A is a half penny crack radius into the depth of the
26 material, where the ratio A/C is equal to one when the half
27 penny crack is a perfect half circl .
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1 11. The method of claim 10 wherein,

2 the applied stress field is a maximum principal stress in
3 MPa and is predetermined from the size and material of the
4 ball.

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6 12. The method of claim 1 wherein,

7 the precrack comprises two longitudinal precracks
8 respectively extending from opposing north and south corners of
9 the indent towards the north and south poles of the ball.

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12 13. The method of claim 1 wherein,

13 the applied load is applied through a load frame applying
14 the applied load to a top platen having a top conforming socket
15 defining a top hemispherical surface of the opposing
16 hemispherical surfaces, and

17 the ball is disposed in a bottom platen having a bottom
18 conforming socket defining a bottom hemispherical surface of
19 the opposing hemispherical surfaces.

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22 14. The method of claim 1 wherein the load determining step
23 comprising,

24 imaging the precracks prior to the applying step,

25 imaging the precracks during the applying step, and

26 imaging the precracks when the precrack begins to grow when
27 the applied load is at the critical applied load.

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1 15. The method of claim 14 wh rein the imaging steps using an
2 imaging microscope focused upon the precrack position at the
3 equator of the ball during the applying step.

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5 16. The method of claim 1 wherein,

6 the precrack comprises opposing half penny latitudinal
7 precracks and opposing half penny longitudinal precracks.

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